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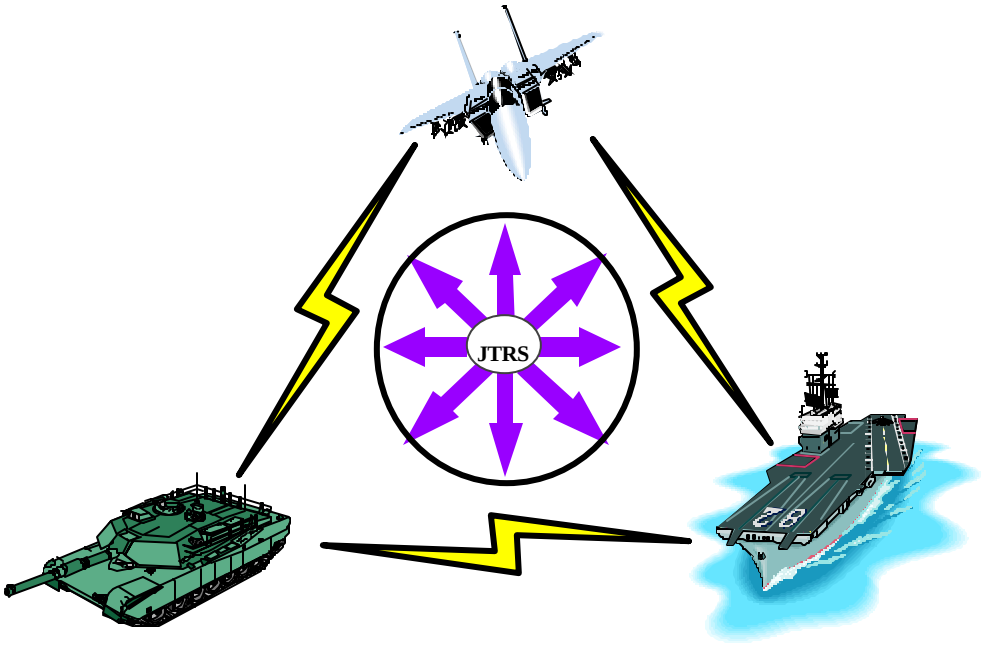
(Waveform Extract – Version a – 28 April 2003)

Joint Tactical Radio System



(EXTRACT OF JROC APPROVED FINAL WITH WAVEFORM TABLE 4-2 AND ANNEX E)

JOINT TACTICAL RADIO SYSTEM (JTRS)

OPERATIONAL REQUIREMENTS DOCUMENT (ORD)

Version 3.2
JROC Approved, JROCM 087-03, 9 April 2003

(Supersedes previous version 2.3 dated 24 April 2002)
ACAT: 1D

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(Waveform Extract – Version a – 28 April 2003)

JTRS WAVEFORMS (By Priority: KPP / Threshold / Objective)

ID	KPP (K)	ID	THRESHOLD (T)	ID	OBJECTIVE (O)
W1	***SINCGARS ESIP** (VHF-FM Military Tactical AJ)	W7	UHF SATCOM Military Protocol (184)	W30	MSS [Waveform Family]
W2	***HAVE QUICK II** (UHF-AM/FM/PSK Military Tactical AJ)	W8	HF-ISB ALE	W32	BOWMAN (UK HF/UHF Military Tactical) [Waveform and Equipment Family]
W3	***UHF SATCOM Military** (181-182-183 "DAMA")	W9	HF-SSB ALE AJ		
W4	***EPLRS**	W10	Link-11 / TADIL-A		
W5	***WNW**	W11	STANAG 5066 (HF Message Protocol)		
W6	***Link 16** / TADIL-J	W12	STANAG 4529 (HF NB Modem)		
		W13	VHF-FM – Military Tactical		
		W14	HF ATC Data Link		
		W15	VHF-AM ATC		
		W16	VHF-AM ATC Extended		
		W17	VHF/UHF-FM LMR: (Land Mobile Radio & Public Safety w/ Project-25 and TETRA) [Waveform Family]		
		W18	VHF ATC Data Link (NEXCOM)		
		W19	UHF-AM/FM/PSK Military Tactical		
		W20	Link-4A / TADIL-C		
		W21	Link-11B / TADIL-B		
		W22	SATURN (UHF PSK AJ NATO)		
		W23	STANAG 4193 Mode S Level 4/5		
		W24	DWTS (UHF PSK WB LOS)		
		W25	Soldier Radio & WLAN & Advanced Capability [Waveform Family]		
		W26	COBRA		
		W27	MUOS-CAI (UHF SATCOM Military Obj.)		
		W28	Cellular Radio & PCS [Waveform Family]		
		W29	Link 22 / NILE		
		W31	IBS-M		
		W32	BOWMAN (VHF)		

TABLE 4-2

Note: Individual waveform characteristics are shown in Annex E.

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(Waveform Extract – Version a – 28 April 2003)

ANNEX E

SUPPORTED JTRS WAVEFORMS CHARACTERISTICS

WAVEFORM (Short ORD Name & Description)	ORD ID	FREQUENCY BAND	NOMINAL CHANNEL BANDWIDTH	INFORMATION VOICE and/or DATA RATES	CRITERIA [and COMMENTS in brackets] [Latest Versions of Documents Shall be Applied]
***SINCGARS ESIP** (VHF-FM Military Tactical AJ)	W1	30-88 MHz	25 KHz	VOICE (A & D 16 Kbps) & DATA 75 Bps to 16 Kbps	Single Channel Ground Air Radio System (SINCGARS) with Enhanced SINCGARS Improvement Program (ESIP). MIL-STD-188-220 & -241-1/-2 compliant. Includes guard (non-hop 40.50 MHz et al) & inband signals ("SINCGARS squelch" 150 Hz tone, et al). Includes AJ.
***HAVE QUICK II** (UHF-AM/FM/PSK Military Tactical AJ)	W2	225-400 MHz	25 KHz	(T) VOICE (A & D 16 Kbps) plus (O) DATA 75 to 16 Kbps (see)	MIL-STD-188-220 & -243 and JIEO-9120A compliant. Includes guard (non-hop 243.0 & 282.8 MHz et al) (but inband signals TBD.) Data 75, 150, 300, 600 Bps; 1.2, 2.4, 4.8, 9.6, 16 Kbps with required IDM.
***UHF SATCOM Military** (181-182-183 "DAMA")	W3	225-400 MHz	5 and 25 KHz	(T) VOICE (A & D) & DATA 75 Bps to 56 Kbps (see) / (O) 64 Kbps	MIL-STD-188-181 & -182 DAMA & -183 DAMA/TDMA compliant. Includes STANAG 4321 version 4. Includes DAMA-C FUW GPRS. Includes DAMA guard lists (but inband signals TBD.) THRESHOLD Data 75, 300, 600 Bps; 1.2, 2.4, 4.8, 9.6, 16, 19.2, 28.8, 32, 38.4, 48, 56 Kbps; and OBJECTIVE up to 64 Kbps (already demonstrated).
***EPLRS**	W4	420-450 MHz	3 MHz [For each of 4 hop bands]	DATA 57 Kbps VHSIC SIP, plus 228 Kbps VECP	Enhanced Position Location Reporting System (EPLRS) with version 11 or higher (in lieu of Situational Awareness Data Link (SADL) functionality). TDMA /CDMA /FDMA. CDRL-4002W-001A compliant.
***WNW**	W5	[Government or Vendor Developed]	[Government or Vendor Developed]	[Government or Vendor Developed]	Wideband Networking Waveform (WNW). Compliant with WNW Functional Description Document (FDD) version 2.31 or later. [New, modified or existing waveform, expected over 2 MHz to 2 GHz at up to 5 Mbps network throughput.] [Guards & inband signals TBD.]
***Link-16** / TADIL-J	W6	960-1215 MHz	3 MHz [51 to 37 freqs]	VOICE (D 2.4 & 16 Kbps) & DATA w/ FEC 28.8 Kbps to 1.137 Mbps	MIL-STD-6016 & STANAG 5516 compliant. Data with FEC 28.8, 57.6, 115.2, 119.0, 238.1 Kbps, up to 1.137 Mbps [FDMA /TDMA /CDMA ECCM-AJ TADIL, with emerging IP bearer services.]
UHF SATCOM Military Protocol (184)	W7	N/A	N/A	N/A	MIL-STD-188-184 Data Control Waveform. Robust link protocol only, required for reliable data transport over UHF SATCOM, normally employing MIL-STD-188-181, -182, & -183 single access, 5 & 25 KHz channels.
HF-ISB ALE	W8	(T) 2-30 MHz (O) 1.5-30 MHz	3 / 6 / 12 KHz	VOICE (A & D) & DATA 75, 150, 300, 600, 1200, 2400, 3200, 4800, 6400, 8000, 9600 Bps, per ISB channel	High Frequency (HF) - Independent Side Band (ISB) with Automatic Link Establishment (ALE). Fully compliant with MIL-STD-188-141B including as mandatory Appendices A - (ALE) & B- Linking Protection (LP) & C- Third Generation (3G) and -MIL-STD-188-110B including as mandatory Appendices C- Data Above 2400 bps & F- Multiple Channel Systems. OBJECTIVE to 1.5 MHz in compliance with STANAG-4203, QSTAG-733, et al. Includes HF guards (non-hop 2182 & 5680 KHz et al) & inband signals (SELCAL et al). [Optional MD-1295/A DATA modem.]

(Waveform Extract – Version a – 28 April 2003)

WAVEFORM (Short ORD Name & Description)	ORD ID	FREQUENCY BAND	NOMINAL CHANNEL BANDWIDTH	INFORMATION VOICE and/or DATA RATES	CRITERIA [and COMMENTS in brackets] [Latest Versions of Documents Shall be Applied]
HF-SSB ALE AJ	W9	(T) 2-30 MHz (O) 1.5-30 MHz	3 KHz	VOICE (A & D) & DATA 75, 150, 300, 600, 1200, 2400, 3200, 4800, 6400, 8000, 9600 Bps per SSB channel	High Frequency (HF) - Single Side Band (SSB) with Automatic Link Establishment (ALE) and Anti-Jam (AJ). Fully compliant with MIL-STD-188-141B including as mandatory Appendices A - (ALE) & B- Linking Protection (LP) & C- Third Generation (3G) and -MIL-STD-188-110B including as mandatory Appendices C- Data Above 2400 bps & F- Multiple Channel Systems and MIL-STD-188-148 HF AJ ECCM. OBJECTIVE to 1.5 MHz in compliance with STANAG-4203, QSTAG-733, et al. Includes HF guards (non-hop 2182 & 5680 MHz et al) & inband signals (SELCAL et al). [Optional MD-1295/A data modem.]
Link-11 / TADIL-A	W10	2-30 MHz and 225-400 MHz	3 and 25 KHz	DATA 1364 & 2250 Bps	MIL-STD-188-203-1A & STANAG 5511 compliant.
STANAG 5066 (HF Message Protocol)	W11	N/A	N/A	N/A	Protocol only, transported over supporting HF waveforms HF-ISB/SSB (W8 & W9) and employing MIL-STD-188-141 & -110. OBJECTIVE to 1.5 MHz in compliance with STANAG-4203, QSTAG-733, et al.
STANAG 4529 (HF NB Modem)	W12	(T) 2-30 MHz (O) 1.5-30 MHz	1.24 KHz	DATA 75, 150, 300, 600, 1200 Bps FEC, up to 1.8 Kbps	Narrowband HF modem standard, transported over MIL-STD-188-141 or STANAG 4203... Requires Forward Error Correction (FEC) coding fully compliant with STANAG 4285 Annex E. OBJECTIVE to 1.5 MHz in compliance with STANAG-4203, QSTAG-733, et al.
VHF-FM – Military Tactical	W13	30-88 MHz	25 KHz and 50 KHz	VOICE (A & D 16 Kbps)	MIL-STD-188-242 compliant. Includes guard (40.50 MHz et al) & inband signals ("new squelch" 150 Hz tone et al). Includes legacy non-AJ for Allied and Coalition interoperability.
HF ATC Data Link	W14	(O) 2-30 MHz (O) 1.5-30 MHz	3 KHz	VOICE (A) & DATA 300, 600, 1200, 1800 Bps	Air Traffic Control (ATC). RTCA DO-265, ARINC 635-3 & -735-3, and FAA TSO-C31d & -C32d compliant TDMA and FDMA. OBJECTIVE to 1.5 MHz in compliance with STANAG-4203, QSTAG-733, et al. [Packet data.]
VHF-AM ATC	W15	(T) 118-137 MHz (O) 108-137 MHz	8.33 KHz [Includes 25 KHz]	VOICE (A) 16 Kbps	Air Traffic Control (ATC). RTCA DO-186a & ARINC 716 compliant and NAS Architecture with future 108-118 MHz (presently VOR/ILS and emergency ATC voice). Navigation uses may require increased reliability and availability. Includes legacy 25 KHz plus European 8.33 KHz. Includes VHF guards (121.5 & 123.0 MHz et al) & inband signals (ELT & SELCAL et al).
VHF-AM ATC Extended	W16	108-156 MHz	25 KHz	(T) VOICE (A) (O) VOR/ILS Nav (A)	Air Traffic Control (ATC), VHF Omni-Range (VOR), and Instrument Landing System (ILS). QSTAG-706 & RTCA DO-186a & -195 & -196 & ARINC 716 compliant, and NAS Architecture with future 108-118 MHz (presently VOR/ILS and emergency ATC voice). Navigation uses may require increased reliability and availability. Includes extended legacy 25 KHz. Includes VHF guards (121.5 & 123.0 MHz et al) & inband signals (ELT & SELCAL et al).
VHF/UHF-FM LMR:	W17	(T) "Low"= 25-54 MHz	"Low" NTIA & FCC (T) 20 KHz	VOICE (A & D 16 Kbps) &	Includes Homeland Security (HLS) & Defense (HLD) legacy interoperability with both NTIA and FCC, digital & analog,

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9 April 2003

(Waveform Extract – Version a – 28 April 2003)

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(Land Mobile Radio & Public Safety w/ Project-25 and TETRA) [Waveform Family]		(T) "Mid"= 72-76 MHz (T) "High"= 136-174 MHz (T) "220"= 216-225 MHz (T) "UHF/T"= 380-512 MHz (T) "800"= 764-869 MHz (O) "TV"= 686-960 MHz	"Mid" & "High" FCC (T) 30 & 15 KHz / (O) 7.5 KHz "High" thru "TV" NTIA & FCC (T) 25 & 12.5 KHz / (O) 6.25 KHz "220" FCC (T) 5 KHz FM & SSB	DATA up to 16 Kbps	"wideband," "narrowband," & future "very narrowband" systems, plus International Maritime VHF. Project-25 compliant includes Common Air Interface (CAI) for subscriber units (not infrastructure) for JTRS unit-unit and unit-infrastructure use. Includes capability for NSA/NIST Type 1 through 4 COMSEC. Includes VHF/UHF guards (47.42, 156.8 / 156.525 and 866.0125 MHz et al) & inband signals (ELT & DSC, CTCSS & DTMF et al). Shall include future upgrade to Terrestrial Trunked Radio (TETRA) and frequency flexibility for overseas LMR bands, including 380-400 MHz NATO Emergency Services and 400-430 MHz European Civil bands, et al. "220" Band utilizes Single Side Band (SSB) and/or Narrow Band FM (NBFM) in 5 KHz. OBJECTIVE includes emerging "TV" bands (channels 70-83 806-in 890 MHz and 50-69 in 686-806 MHz.).
VHF ATC Data Link (NEXCOM)	W18	118-137 MHz	25 KHz	VOICE (D 4.8 Kbps) & DATA 31.5 Kbps	RTCA DO-186a & -224a compliant, a.k.a. VDL 2 & 3 Next Generation Communications (NEXCOM) FUW FAA CONUS and overseas & military ATC.
UHF-AM/FM/PSK Military Tactical	W19	(T) 225-400 MHz (O) 225-450 MHz	5 and 25 KHz	(T) VOICE (A & D 16 Kbps) & (O) DATA up to 16 Kbps (w/ IDM)	MIL-STD-188-181B & -243 compliant. Includes FAA CONUS and overseas & military ATC operations. Includes UHF guards (243.0 / 282.8 / (O) 406.025 MHz et al) & inband signals (ELT & SELCAL, CTCSS & DTMF et al). OBJECTIVE includes ability to exploit (both transmit and receive) 406 beacon position location systems, including interface to GPS, IAW TSO C-126. [Data up to 16 Kbps w/ optional IDM.] [Optional implementation of VDL 2 & 3 NEXCOM FUW FAA CONUS up to 31.5 Kbps]
Link-4A / TADIL-C	W20	225-400 MHz	25 KHz	DATA 5 Kbps	MIL-STD-188-203-3 compliant.
Link-11B / TADIL-B	W21	225-400 MHz	25 KHz	DATA 600, 1200, 2400 Bps	MIL-STD-188-212 & STANAG 5511 compliant
SATURN (UHF PSK AJ NATO)	W22	225-400 MHz	25 KHz	VOICE (D) & DATA [Rates TBP]	Second generation Anti-jam Tactical UHF Radio for NATO (SATURN). STANAG-4372 & JIEO-9120A compliant. [See also W2 AJ, and W19 non-AJ.]

(Waveform Extract – Version a – 28 April 2003)

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STANAG 4193 Mode S Level 4/5	W23	1030 & 1090 MHz	3.5 MHz / 3 MHz	DATA 689.7 Bps (1.45 uS PCM) IFF Family, and 9.6 to 128 Kbps Mode S, plus others per Standards.	Fully compliant with STANAG 4193 including Mode Select (Mode S), Levels 5 & 4 lower. THRESHOLD includes both transponders and interrogators on platforms and at low transmit powers. OBJECTIVE includes upgrade to high power (ground-based and airborne warning et al) interrogators. Includes Mark X & XII/A with all Identification Friend or Foe (IFF) and Selective Identification Feature (SIF) Modes 1 through 5 and A & C, and ACP-160 and ICAO Annex 10 compliance. Includes civil secondary Air Traffic Control Radar Beacon System (ATCRBS), Airborne Collision Avoidance System (ACAS) and Traffic Alert & Collision Avoidance System (TCAS), and Automatic Dependent Surveillance – Addressable (ADS-A) and Broadcast (ADS-B) functionality. Includes supporting interface to GPS and other systems for flight, navigation and timing data. ADS requires interface to SATCOM, VHF Data Link, and other alternate channels IAW platform capabilities and mission needs. Includes generation of, and detection and alarm on, emergency messages, including ATCRBS (7700 emergency, 7600 communications failure, et al) and special military (4X et al) codes.
DWTS (UHF PSK WB LOS)	W24	1350-1850 MHz (NATO Band 3)	125 KHz	VOICE Order Wire (A & D) and DATA 144, 256, 288, 512, 576, 1024, 1152, 1544, 2048, 2304 Kbps	Digital Wideband Transmission System (DWTS). Shipboard system for high capacity secure & nonsecure, line-of-sight (LOS), ship-to-ship, and ship-to-shore, digital voice/data/imagery communications in the UHF range and interface into Marines ashore and Army Mobile Subscriber Element (MSE) et al.
Soldier Radio & WLAN [Waveform Family]	W25	(T) 1.755-1.850 GHz Army LW 2.450-2.483.5 GHz COTS	13 MHz (COTS provides 11 overlapping channels)	(T) VOICE (D 16 Kbps) & DATA 1 Mbps DATA 1, 2, 5.5, 11 Mbps	Wireless Local Area Network (WLAN). Army Land Warrior (LW) Program includes basic Direct Sequence Spread Spectrum (DSSS) IEEE 802.11 wireless Ethernet LAN standard at 1 Mbps. Includes security capability up to NSA Type 1. Includes COTS multiple channels in 2.4 GHz band and upgrade to 802.11b 11 Mbps. 802.11e FEC & 802.11g 54 Mbps et al, plus use of dual diversity antennas. Advanced Capability: 350 MHz – 2.5 GHz; 350 MHz – 1GHz (Band 2); & 1 GHz – 2.5 GHz (Band 3) [Guards & inband signals not known to be applicable.]
COBRA	W26	340-400 MHz	TBP	TBP	Includes interoperability with CSEL et al and support for GPRS and CSAR. [Characteristics to be provided to authorized users.]
MUOS-CAI	W27	240-320 MHz	5 & 25 KHz	DATA 2.4, 9.6, 16, 32, 64 Kbps	Mobile User Objective System (MUOS) – Common Air Interface (CAI). [Guards & inband signals TBD.]

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Cellular Radio & PCS [Waveform Family]	W28	(T) 824-894 MHz (T) 890-960 MHz (T) 1850-1990 MHz (O) 1850- 2200 MHz IAW standard & Host Nation	30 KHz to 1.6 MHz 3G to 5xN MHz IAW standard & Host Nation	VOICE a/o DATA – 10 Kbps nominal 3G DATA up to 144/384 Kbps & 2 Mbps IAW standard & Host Nation	Includes multiple US and overseas standards – TR-45.1 AMPS & IS-54 TDMA & -IS-95b CDMA & IS-136 HS TDMA & GSM & 3GSM & 2.5G & 3G & WCDMA & CDMA-2000 et al compliant. Includes both cellular telephone and Personal Communications Services (PCS), providing voice, data, short message services (SMS), et al... Includes Enhanced Specialized Mobile Radio (ESMR), interoperable with 900 MHz band and iDEN (NEXTEL, Southern-Link, et al) protocols, et al. Includes capability for NSA/NIST Type 1 through 4 COMSEC. Shall include ability to use any available Wireless Priority Access Service (WPAS) or equivalent for assured access and capacity. Shall include ability to exploit cell phone position location systems, including interface to GPS. Includes inband signals (DTMF et al). [Note – 1994 FCC PCS plan 1850-2200 MHz.]
Link 22 / NILE	W29	3-30 MHz and 225-400 MHz	TBD	DATA (rate TBD)	NATO Improved Link Eleven (NILE). STANAG 5522 compliant. Requires modem waveforms in STANAG 4539 Annex D.
MSS [Waveform Family]	W30	137-150 MHz 1.61-2 [2.5] GHz and per system	TBD per system	VOICE (D 2.4 to 9.6 Kbps et al) & DATA 2.4, 9.6 Kbps up to 2.048 Mbps per system	Mobile Satellite Service (MSS). Includes both VHF and UHF MSS bands and both fielded and emerging LEOSAT & MEOSAT systems and standards, such as IRIDIUM, Globalstar, et al. Includes capability for NSA/NIST Type 1 through 4 COMSEC. OBJECTIVE includes capability to utilize GEOSAT systems such as Motient (formerly AMSC) and INMARSAT, et al. Addition of appropriate antenna systems may be required. OBJECTIVE also includes future expansion bands to 2.5 GHz. [OBJECTIVE includes transoceanic aviation use of INMARSAT AERO-I and AERO-H FUW GANS and GATM.]
IBS-M	W31	225-400 MHz	5 and 25 KHz	DATA 2.4, 4.8, 9.6 & 19.2 Kbps	Integrated Broadcast Service Module (IBS-M). As a "Single JTRS Channel" and multiples as follows – THRESHOLD is parallel receive 4X & transmit 0X data streams, implemented in a single "JTRS channel" and OBJECTIVE is up to receive 12X & transmit 4X; potentially implemented as several "JTRS channels" with all cases including necessary multiple cryptographic streams. Integrated Broadcast Service (IBS) - Currently consists of three legacies UHF broadcasts (TIBS, TDDS, and TRIXS) which will be replaced in the future with a Common Interactive Broadcast (CIB). The CIB will be a DAMA compliant broadcast using a developing Integrated Waveform, MIL-STD-188-181C/-182B/-183B. Data carried over IBS will be an IBS Common Message Format (CMF), which will be a member of the J-Series family of message formats."

WAVEFORM (Short ORD Name & Description)	ORD ID	FREQUENCY BAND	NOMINAL CHANNEL BANDWIDTH	INFORMATION VOICE and/or DATA RATES	CRITERIA [and COMMENTS in brackets] [Latest Versions of Documents Shall be Applied]
BOWMAN (UK HF/VHF/UHF Military Tactical) [Equipment Family]	W32	HF-1.6 60 MHz VHF- 30-80 MHz UHF-225-450 MHz	3 KHz 25 KHz 600 KHz & 4MHz	75-2400 bps 156 Kbps 500 Kbps	"BOWMAN" is the designator for the UK Tri-Service Tactical communications System. [Guards & inband signals TBD.] Includes BOWMAN-HF (per Harris RF-5800), BOWMAN-VHF (per ITT ADR+ variant of SINCGARS) and BOWMAN-UHF (per ITT High Capacity Data Radio (HCDR) variant of Naval Tactical Data Radio (NTDR)). [NOTE - US-UK interoperability criteria under negotiation by OSD and JS.]

TABLE E-1 SUPPORTED JTRS WAVEFORMS CHARACTERISTICS

Note: *= KPP (also shown in **BOLD**)